OBSERVATIONS

ON

SEVENTY-FIVE CASES OF FLAT FOOT

WITH PARTICULAR REFERENCE
TO TREATMENT

Compliments of

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OBSERVATIONS ON SEVENTY-FIVE CASES OF FLAT FOOT,

With Particular Reference to Treatment.

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FLAT FOOT is, in the majority of cases, an affection independent of local or constitutional disease, which may develop at any age, the most important factor being overwork, for feet subjected to mechanical disadvantages, in attitudes of activity as well as of rest.[1]

The following points may be urged in support of this assumption, since the first essential in the treatment of any deformity must be a proper conception of its cause.

In the normal foot the astragalus has a tendency to slip downward and inward from off the os calcis. There are two principal reasons for this tendency: —

1. The weight of the body, transmitted through the astragalus, falls upon the os calcis at a point internal to its base, and thus tends to roll it over towards the inside, presenting an inclined plane for the support of the leg.

2. The displacement of the astragalus found in flat foot is simply an exaggeration of its normal position under weight; that is, the result of a rotation or slipping forward, downward, and inward, — the only movement which its articulating surface permits; a rotation, not only with the attached leg above, but also a slight independent rotation of its own, amounting in the normal foot, according to thirty measurements, to about four millimetres.[2]

[1] Mr. Lane, in his instructive article on flat foot in children, says: "A general want of tone and vigor is solely and primarily responsible for the condition, except in cases which have resulted from a wound or rheumatism." Under such conditions he considers the habitual assumption of attitudes of rest as the exciting cause. Guy's Hospital Reports, 1887.

[2] Boston Med. and Surg. Journal, June 14, 1888.

Thus it is apparent that an increased rotation of the astragalus will increase the instability of the os calcis, and, conversely, a depression of the internal border of the os calcis will increase the rotation of the astragalus; and that an increase in the weight to be supported, or a decrease in the strength of the supporting muscles and ligaments, may result in the symptoms and appearances of flat foot.

In flat foot, then, we may expect to find a sinking and rolling over of the os calcis, an exaggerated rotation with inward and downward displacement of the astragalus, the scaphoid displaced downward, and with the forefoot outward; so that the leg will appear to be rotated inward upon the foot, or rather the foot will appear to be displaced outward upon the leg. These displacements are accompanied by overstretched and ruptured ligaments, weakened muscles, and, in time, permanent changes in bone and soft parts.

Thus overweight or overwork, sudden or gradual, or weakness of muscles either from disuse or from general or special disease or accident, may induce the condition known as flat foot; and in all, whether it be the weak ankles of the growing child, the painless flat foot of rachitis, or the acute cases in adults accompanied by inflammation and muscular spasm, we find to a greater or less degree the anatomical conditions which have been described; and although certain cases can perhaps be explained by the various hypotheses which have been advanced, none will so satisfactorily account for the great majority as will the simple mechanical theory of its causation.

The natural mechanical disadvantages of the foot have been still further increased by faulty attitudes assumed in standing and walking, and by disuse of the muscles of the foot, with deformities caused by improper shoes. To illustrate: As the foot is dependent on muscular strength and activity for its support, evidently anything tending to produce muscular weakness or to place the muscles at a disadvantage will tend to cause a giving way at its weakest part, which is the inside, for reasons which have been stated. The attitude of muscular weakness, as shown in infancy and old age, is with the feet wide apart, and the toes widely separated, to increase the base of support.

On the contrary, the attitude of muscular strength and activity is with the feet well under the body, and the toes pointing straight ahead, as illustrated by the antique statues. The walk of muscular inactivity and weakness is the walk of flat foot; the step is short and inelastic, the toes widely divergent, the weight borne almost entirely on the inside of the heels. The foot resting flat upon the ground is lifted by an exaggerated bend of the knee, the final strain falling entirely on its weakest part.

The walk of muscular activity and strength is with the feet under the body and the toes pointing straight ahead, so that the weight, falling first on the outside of the heels, is transmitted along the outside of the foot; the body is then lifted by a well-marked flexion of the foot, in which the toes assist. The final impulse is given by the powerful muscles of the great toe, the forefoot being slightly adducted. Thus the arch is almost entirely relieved from strain; the gait is elastic, and the step is longer than in the preceding.

As flat foot must cause the walk of weakness, so an approximation to the attitude and walk of weakness may induce flat foot. It is to this point I wish to call attention, because it has been almost, if not entirely, overlooked by writers on this subject.

The usual walk of civilization is an approximation to the walk of weakness, (1) because the muscles of the foot are weakened from disuse, — for the ordinary shoe causes not only direct atrophy of muscles from pressure, but indirectly, from corns, bunions, and deformities of the toes, which render flexion of the foot a painful act, consequently it is avoided. (2) The foot is subjected to a mechanical disadvantage by the exaggerated turning out of the toes, the result of habit and instruction as well as of weakness and deformity. Children are constantly reminded to turn their toes out in walking; in the military drill of the public schools they are obliged to stand for long periods, the angle of divergence for both feet prescribed by tactics being 60°, but often increased to one of 90°.

In such positions the strain on the feet is greatly increased, especially in the attitude of rest, when the weight of the body falling on one foot must be borne by the unsupported ligaments.

The walk, with little or no divergence of the toes, is the walk intended by Nature. The construction of the foot shows it particularly, in the diagonal line of the balls of the toes, — the outer

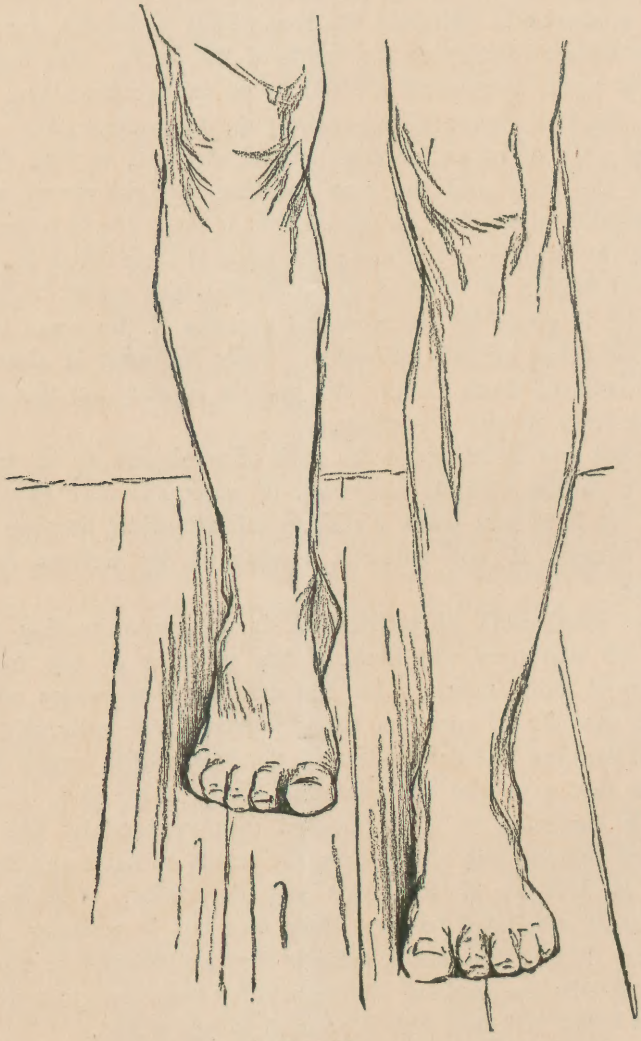

Fig. 45.

the short, the inner the long side. With the foot in the proper position, this outer side first bears the shock of weight, and fixes

the forefoot; the scaphoid is raised and approximated to the os calcis, relieving the strain on the ligaments.

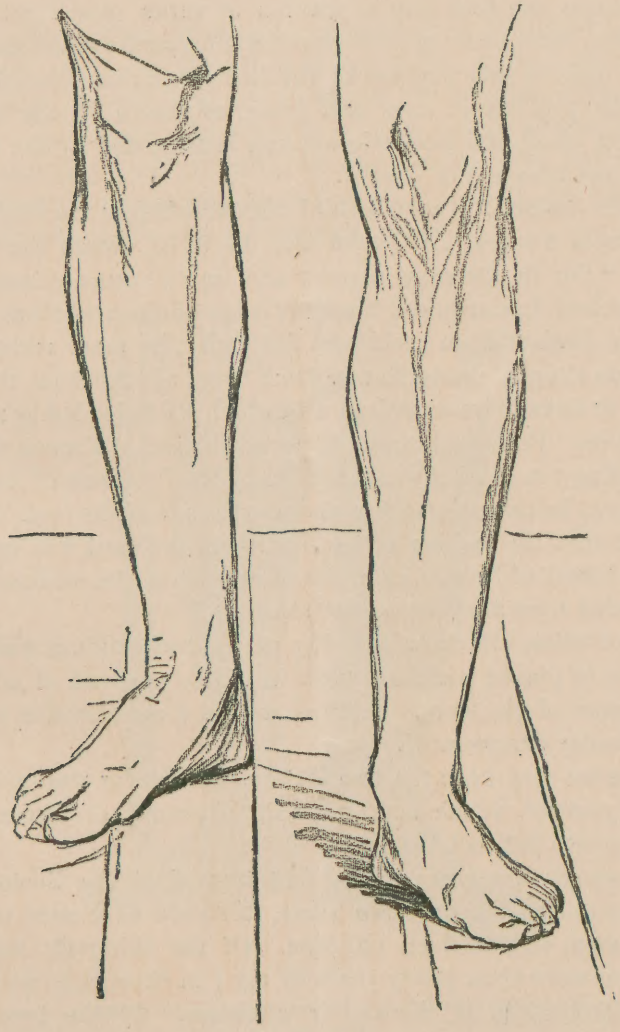

FIG. 46.

Fig. 45 (drawn from life) shows the correct position of the feet in walking; Fig. 46 (drawn from life), the incorrect. A line drawn through the patella downward to the floor will show where the strain falls, — in Fig. 45 through the middle of the foot, in Fig. 46 across its weakest part.

As the leg is extended, the astragalus (the forefoot being a fixed point) must, from the arrangement of the knee joint, rotate outward with the leg. An exaggeration of these movements will throw the foot into a position of varus (see right leg in Fig. 45); thus, every correct step is a safeguard against flat foot.[1]

Not only is this position of the foot correct anatomically, but it is the position of ease and grace, as shown by the healthy barefoot child, the moccasin-wearing Indian, and by the statues of the sandal-wearing Greeks.

In Sir Joshua Reynolds's third discourse before the students of the Royal Academy, delivered Dec. 14, 1770, occurs the following: "For in the same manner and on the same principles as the student has acquired the knowledge of the real form of Nature as distinct from accidental deformity, he must endeavor to separate simple, chaste Nature from those adventitious, those affected or forced airs or actions with which she is loaded by modern education. Perhaps I cannot better explain what I mean than by reminding you of what was taught us by the Professor of Anatomy in respect to natural position and movements of the foot. He observed that the fashion of turning them outward was contrary to the intent of Nature, as might be seen from the weakness that proceeded from that manner of standing."

Observation will show that fifty per cent of children walk with the feet in proper position; while in ninety per cent of adults a divergence of the toes is habitual, and in a considerable proportion greatly exaggerated.

Thus we may have the two factors — muscular weakness and faulty position, which sudden strain, overwork, or disease may develop into flat foot.

Of seventy-five cases of flat foot treated at the Boston Dispensary during the past two years, thirty-six were men, twenty-six women, and thirteen children. Of the thirty-six men but six were more than thirty years of age; in three only was there any complication of disease or weakness. Of the twenty-six women, eleven were less than thirty, while twelve were more

[1] If the toes are in front of the body, they must be walked over; that is, the weight of the body must be lifted by the muscles attached to the foot. On the contrary, in the position of excessive divergence, the feet are used simply as passive mechanical supports, and are pushed along by the legs.

than forty; the greater number of whom were fat, and altogether too heavy for their feet, while fifteen per cent were rheumatic. Of the children but two were free from weakness or disease.

This is, as might be expected, according to the theory which has been advanced, typical flat foot being more common in young men whose feet are subjected to greatest strain and weight. In women, whose work is of a lighter character, the proportion is greater in later life, for reasons above mentioned. In children not subjected to overwork, as a rule, the affection is usually the result of constitutional weakness.

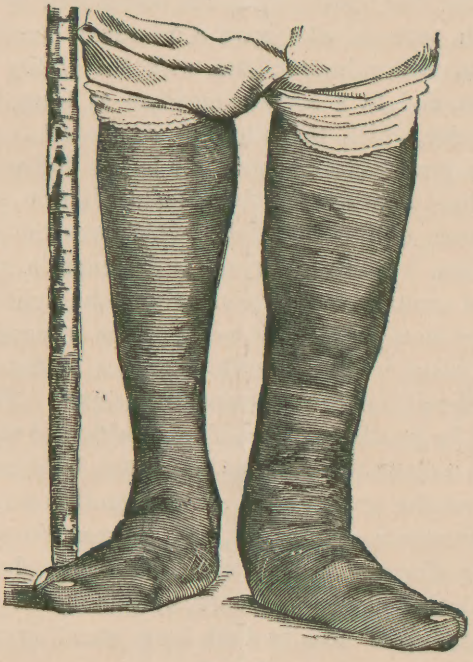

FIG. 47.

Fig. 47 (from a photograph taken at the Boston Dispensary) illustrates the more severe class of cases in which muscular exercise alone is useless, — a barber who standing all day by his chair "has endured misery for fourteen years."

As it is evident that treatment should be directed to cause rather than effect in these cases resulting from general or local

disease, I shall confine myself to the treatment of the affection as it usually occurs, independent of either.

Flat foot being essentially a dislocation, it is evident that its symptoms can be relieved, and the functions of the foot restored, only by a reduction of the misplaced bones, and their retention in normal position.

If such retention can be accomplished by a suitable brace, then, by an avoidance of faulty position, and in exercises for strengthening the muscles, we may hope for permanent cure.

It is asserted, however, by those who reject all forms of support, that this result can be best accomplished by gymnastic exercises alone.[1]

It is true that the milder cases can be relieved by this means, but only with patients who have a personal, persistent, intelligent desire to follow instructions, with the ability to take the necessary rest, and, in a certain measure at least, to avoid the conditions under which the affection developed.

Among the poorer classes not only is the desire or ability to follow directions wanting, but there is, in addition, the necessity of a continuance of the daily labor which was the direct cause of the affection. *Operative treatment*,[2] except in special cases, on anatomical grounds, and particularly in the light of published autopsies, may be rejected, as it could not be successful in severe and chronic cases, while the milder grades of flat foot may be cured or relieved by less extreme measures. *The treatment recommended by Smith*[3] — a forcible re-position of the foot, under ether, and its indefinite retention in plaster bandages — may be objected to, on the ground that such retention would interfere with the movements of the foot, and prevent the exercises for strengthening the muscles, on which we must place our main reliance; and that permanent cure, by this means alone, is unlikely, as the author admits that long standing and walking must be avoided.

If a support is to be used at all, it should be efficient and comfortable. We may therefore object to the indirect support

[1] Roth, N. Y. Med. Record, March 17, 1888; T. S. Ellis, Lancet, Sept. 25, 1885.
[2] Ogston; Stokes, Annals of Surgery, October, 1885.
[3] The Practitioner, January, 1887.

afforded by shoes of peculiar shape as recommended by Thomas[1] and Mayo Collier,[2] as being inefficient; to *pads* of horsehair, india-rubber, or felt, as not only inefficient, but, according to those who have used them, often painful; to *elastic supports* — that is, an elastic band passing under the arch and attached to the corset[3] or to a steel support,[4] as being likely to cause painful pressure, to interfere with the action of the muscles against which they press, and because, from the nature of their elasticity, they must give, under weight, and thus allow the displacement of the bones which it is their object to prevent.

This last objection may also be urged against *steel springs*;[5] for it must be remembered that with the foot in its proper position the normal arch does not, to an appreciable extent, sink under weight, as would seem to be the impression of those who recommend elastic supports or springs, the abnormal sinking of the arch in flat foot being exactly what we wish to prevent. *The only inelastic brace* with which I am acquainted, though a very useful appliance, is open to the following objections, — that it is heavy, and, reaching from the heels to beyond the balls of the toes, acts as a splint, interfering with the natural movements of the foot, and causing an awkward gait; and that it is not entirely efficient as a support.

It would appear, then, that a brace should be constructed on principles somewhat as follows: it should be *light*, *inelastic*, *comfortable*, and must not to any extent interfere with the movements of the foot or the action of its muscles. As, from the excessive divergence of the forefoot, the metatarsal bone of the great toe has borne more than its share of work, it should be supported; the other metatarsals should be unsupported.

The brace must fit the foot perfectly, and prevent displacement, especially at the moment when weight is borne, when there is always a tendency for the foot to slide off from any support.

[1] H. O. Thomas.
[2] Lancet, Sept. 4, 1886.
[3] Green, Lancet, Dec. 26, 1885.
[4] Walsham, Lancet, Dec. 26, 1885; Sayre, Orthopedic Surgery.
[5] Lane, *loc. cit.*; Sayre, *loc. cit.*

An attempt has been made to meet these requirements in the brace which is presented for your consideration. It is constructed as follows: The flat foot is by manipulation replaced as far as possible in its normal position.[1] The foot being at right angles to the leg and slightly flexed at the medio-tarsal joint, a plaster cast is taken, on which the lines for the plate are drawn.

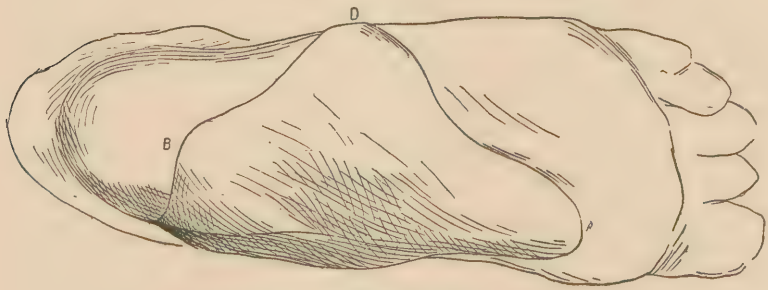

Fig. 48.

Fig. 49.

The point A is made beneath the ball of the great toe, just short of its bearing centre; a point B, just short of the bearing centre of the heel bone, beneath its inner tuberosity, so that the foot

[1] In an acute case, accompanied by pain, redness, and swelling, the foot should be placed for a few days in a plaster bandage in an adducted and inverted position; afterwards rubbing and bandaging will bring it into condition for the plate. In old cases a forcible breaking up of adhesions and re-position under ether is sometimes necessary.

may rest upon its natural supports; C, just above the head of the astragalus, a little in front and below the internal malleolus.

These three points are now connected by a gradually ascending line from A, rising above the inner border of the foot, a little in front of the internal cuneiform bone, curving upward above the scaphoid, meeting at C the line drawn upward from B.

A curved line is drawn, three quarters of an inch in length, whose centre corresponds to a point D on the outer aspect of the foot, just above and behind the tuberosity of the fifth metatarsal. The extremities of this line are now connected with A and B, and the pattern is completed.

The brace should be made of thin-tempered steel, accurately moulded on the cast. It presents the following peculiarities: It has the two bearing points A and B, while the extremity D forms a lever, caused by the slight flexion of the foot during the taking of the cast; for although in standing the entire outer border of the foot rests upon the floor, as may be seen from the imprint of a wet foot on paper, the medio-tarsal joint being flexed, this outer border is slightly raised, an interval of one quarter to one third of an inch intervening between it and a line drawn from the heel to the head of the first metatarsal.[1] The brace being fitted to the cast in this position, it results that the foot in standing or walking will press this external arm or lever solidly against the sole of the shoe; consequently the tendency will be to press the internal flange more firmly against the weak portion at the moment when the tendency of the foot is to slide away from it.[2] This pressure during the step has a tendency to throw the weight more on the outside of the foot, and to turn the toes in, resisting the tendency to exaggerated abduction. It is worn next the stocking, may be changed from one shoe to another, and its presence cannot be detected. Its weight is about an ounce; it may be nickel or silver-plated, or the inside covered with rubber plaster to prevent rusting. Well-fitting laced shoes on the Waukenphast pattern, with broad soles and low heels, should be worn.

[1] The outer third of the arm D must be perfectly flat, so that when pressed down it may lie smoothly against the sole of the shoe.

[2] The leverage should be just sufficient to cause the brace to hug the foot closely when weight is borne.

Objections have been urged against this class of support: —

1. That they prevent the natural movements of the foot.

This is not true of the brace which has been described.

2. That they cause painful pressure; an objection which is disproved by practice.

3. That they are theoretically wrong, as it is impossible to provide pressure at the proper place.

As to this, it may be said that the bones of the foot are so closely bound together that a change in the position of one necessitates a corresponding change in all the others. A proper brace will prevent the downward and outward displacement of the scaphoid; to a great extent the inward rotation of the astragalus; and, most important of all, the sinking and inward rotation of the anterior extremity of the os calcis, — a movement which unhooks it from the cuboid, thus not only directly preventing the deformity, but indirectly by its suggestiveness, for a brace accurately fitted to the foot in a proper position can only be uncomfortable to the foot in an improper position. In other words, to avoid uncomfortable pressure, the patient voluntarily assumes the correct position in standing or walking, — a position which will necessitate activity of the muscles.

Thus the best exercise for flat foot will be the simplest, —a proper walk.

Games which employ the feet, such as skipping rope, tennis, dancing, also bareback riding, bicycling, etc., are to be recommended. Also exercises for the bare feet, such as raising the body on tiptoe with the toes in an inverted position; walking a mark or narrow plank; raising a weight by a cord running over a pulley, as recommended by Mr. Ellis.[1] In addition, manual flexion and inversion of the foot is often of service.

As to results, there is no affection for which treatment conducted on simple mechanical principles is more satisfactory to patient and physician than typical flat foot.

The more acute and disabling the symptoms, the more rapidly efficacious the remedy. In old cases, with permanent changes in the bones, we can scarcely hope to do more than relieve the symptoms; neither can we expect a fat middle-aged man or

[1] Lancet, Sept. 26, 1885.

woman to greatly improve the muscular tone by gymnastic exercise.

The brace is designed as a temporary support; but the length of time it should be worn must vary according to the case.

In conclusion, it would seem that weakness of the feet may often be prevented by teaching children the proper attitudes in activity and rest, and by avoiding improper shoes. The ideal shoe should have a sole approximating in shape the Greek sandal, as thin as circumstances will allow, for a stiff sole acts as a splint to the foot. Young children might wear the Indian moccasin, and surely fashion need not dictate the shape of tennis shoes, now so universally worn in summer.